



AFCI Systems Analysis Overview

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Outline



- **Relationship of AFCI and Generation IV programs**
- **AFCI Systems Analysis Overview**
- **Objectives**
- **Key Activities**
- **Milestones and Deliverables**



AFCI and Generation IV Comparison



AFCI Focus

- Treatment and transmutation
- Deployment in U.S.
- Evolving goals and criteria
- Technology demonstration to affect repository decisions in 5 yrs
- Deployment to affect inventory in ~ 15 yrs

Generation IV Focus

- Complete nuclear energy system
- Deployment internationally
- Internationally-developed 'Generation IV goals'
- Technology demonstration in 5-15 yrs
- Deployment in 15-25 yrs



AFCI and Generation IV Goals



AFCI Goals

- **Reduce high-level nuclear waste volume** (20:1 mass reduction; 4:1 volume reduction)
- **Reduce the cost of geologic disposal** (with net savings of \$35-40B from 2007 to 2040)
- **Reduce inventories of civil plutonium** (with proliferation-resistant U/Pu/Np or U/Pu/Np/Am fuels in LWRs)
- **Reduce the toxicity of high-level nuclear waste** (to the toxicity of natural uranium ore within 1000 years)

Generation IV Goals

Sustainability–1 Generation IV nuclear energy systems will provide sustainable energy generation that meets clean air objectives and promotes long-term availability of systems and effective fuel utilization for worldwide energy production.

Sustainability–2 Generation IV nuclear energy systems will minimize and manage their nuclear waste and notably reduce the long-term stewardship burden, thereby improving protection for the public health and the environment.

Economics–1 Generation IV nuclear energy systems will have a clear life-cycle cost advantage over other energy sources.

Economics–2 Generation IV nuclear energy systems will have a level of financial risk comparable to other energy projects.

Safety and Reliability–1 Generation IV nuclear energy systems operations will excel in safety and reliability.

Safety and Reliability–2 Generation IV nuclear energy systems will have a very low likelihood and degree of reactor core damage.

Safety and Reliability–3 Generation IV nuclear energy systems will eliminate the need for offsite emergency response.

Proliferation Resistance and Physical Protection–1 Generation IV nuclear energy systems will increase the assurance that they are a very unattractive and the least desirable route for diversion or theft of weapons-usable materials, and provide increased physical protection against acts of terrorism.



Steps Toward Program Integration

- **AFCI Report to Congress to be issued soon**
- **Generation IV Roadmap due to Congress March 1, 2003**
- **Generation IV U.S. Implementation Plan due to Congress March 31, 2003**
- **DOE Steps to Integrate the Programs**
 - Program organizations are complementary
 - Programs interact through *product managers* and *national directors*
 - Program guided with a common *systems analysis* group



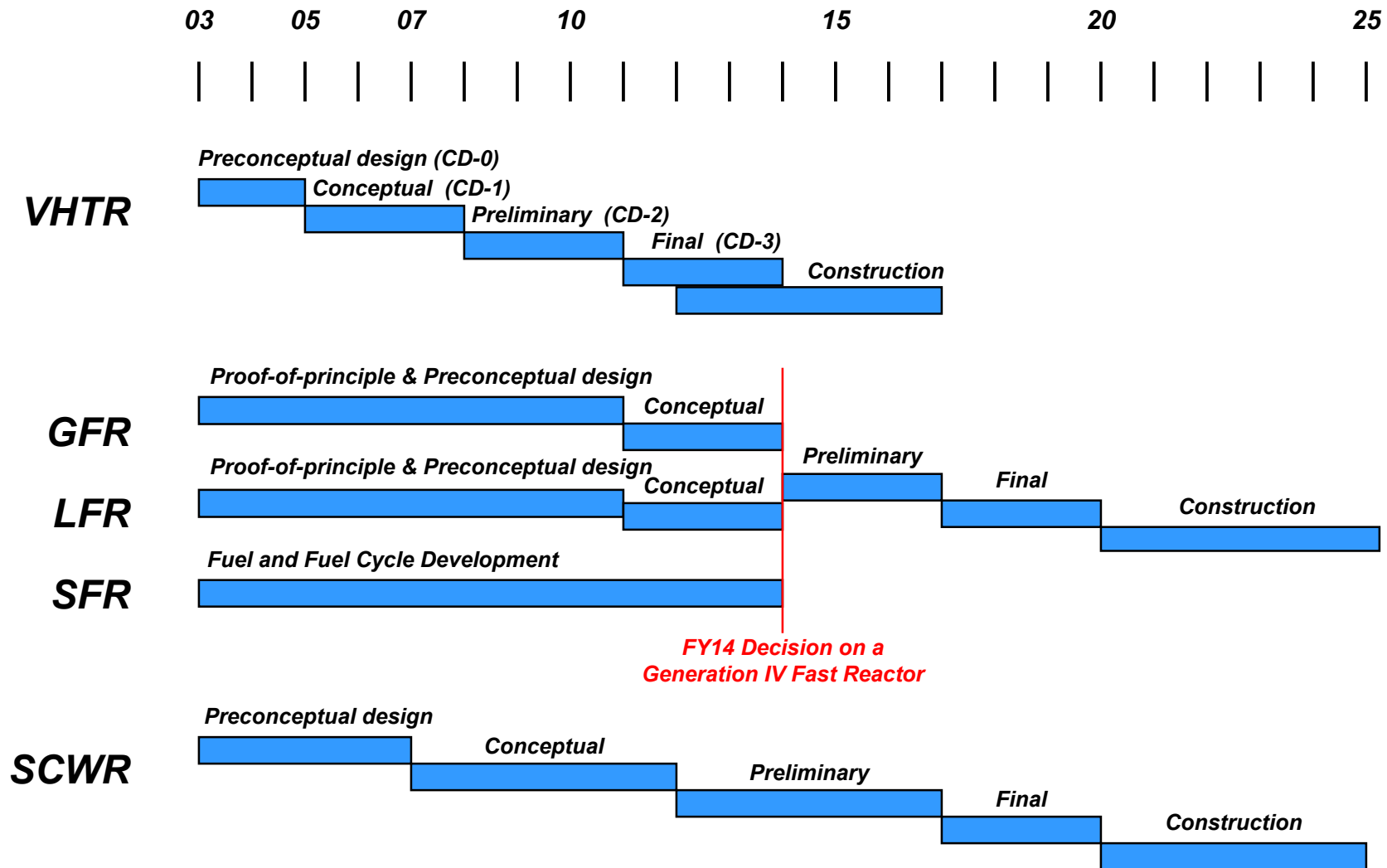
Generation IV Implementation Plan



- **Identifies technology development needs for**
 1. New systems to address the barriers to expansion of nuclear energy in the U.S.
 2. New system to address the need to diversify the transportation sector with hydrogen
- **Reflects the following priorities for Generation IV**
 1. VHTR for hydrogen production
 2. Fast-spectrum system (GFR, LFR, SFR)
 3. SCWR for electricity production



U.S. Generation IV Timeline





Questions for Systems Analysis

For the AFCI:

- *What are the overall benefits of an Advanced Fuel Cycle?*
- *What are the benefits to the first repository?*
- *What is needed (technology, facilities, capabilities) to achieve the benefits?*
- *What is a defensible baseline for the actions needed to achieve the benefits?*
- *What is needed to significantly delay or avoid a decision on the second repository before 2010?*

All of these depend upon an ability to analyze proposed fuel cycles at varying levels of detail and accuracy.

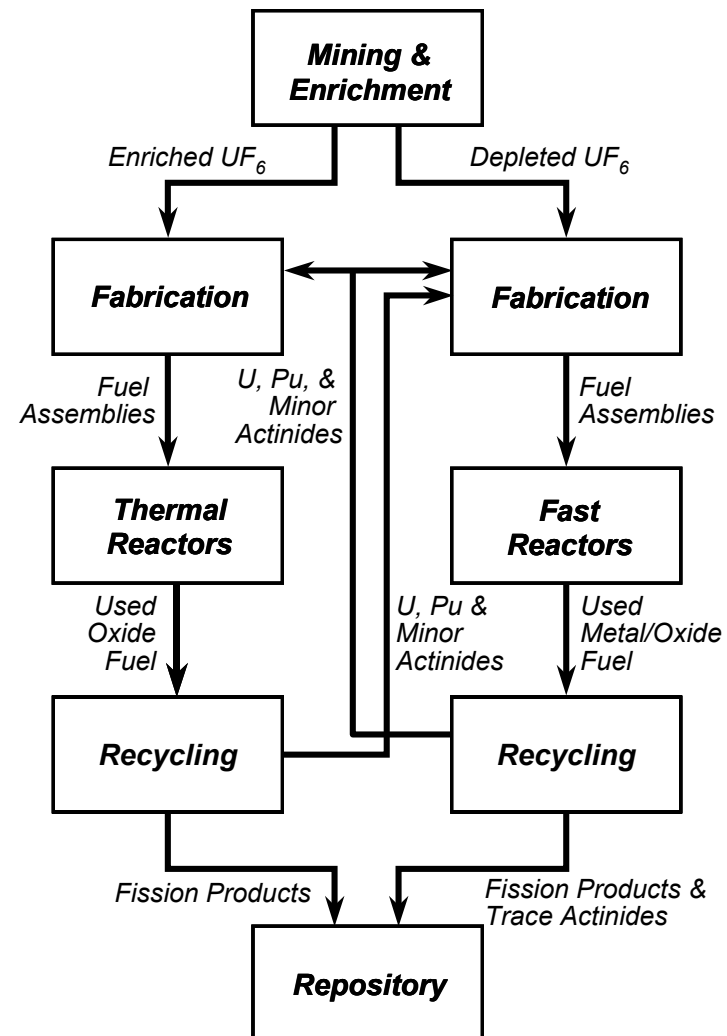


Symbiotic Fuel Cycles



Generation IV anticipated such combinations, and explored some general aspects of their time evolution and equilibrium, but never resolved which were preferred.

AFCI has also explored a number of options for deployment





Systems Analysis Hierarchy

*Broader
Viewpoint*

- Broad Systems Studies
- Transmutation Systems Studies and Integrated Model Development
- Individual Generation IV Studies
- Technology/Facility Assessments

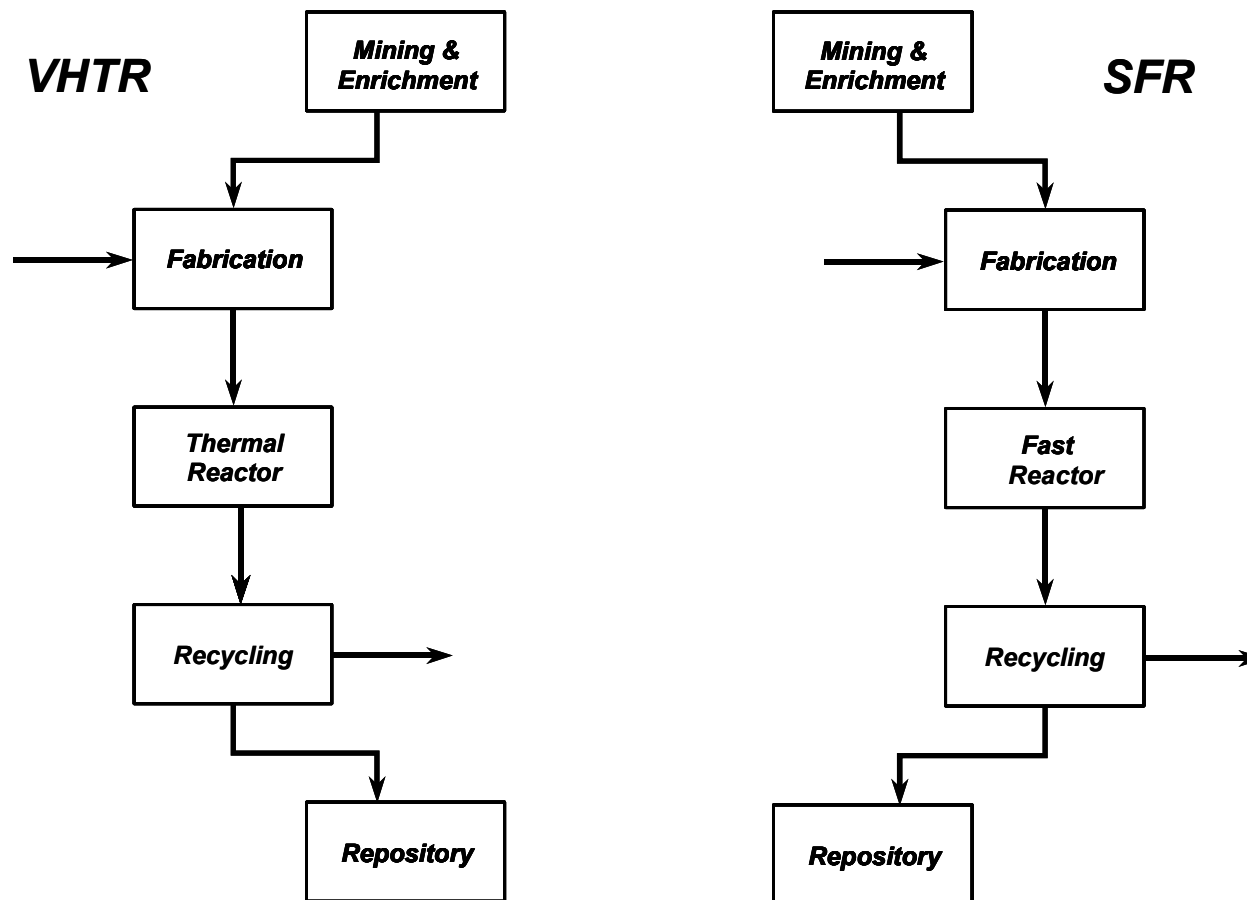
*Detailed
Assessment*



Individual Generation IV Studies



These are addressed by the product teams in Generation IV

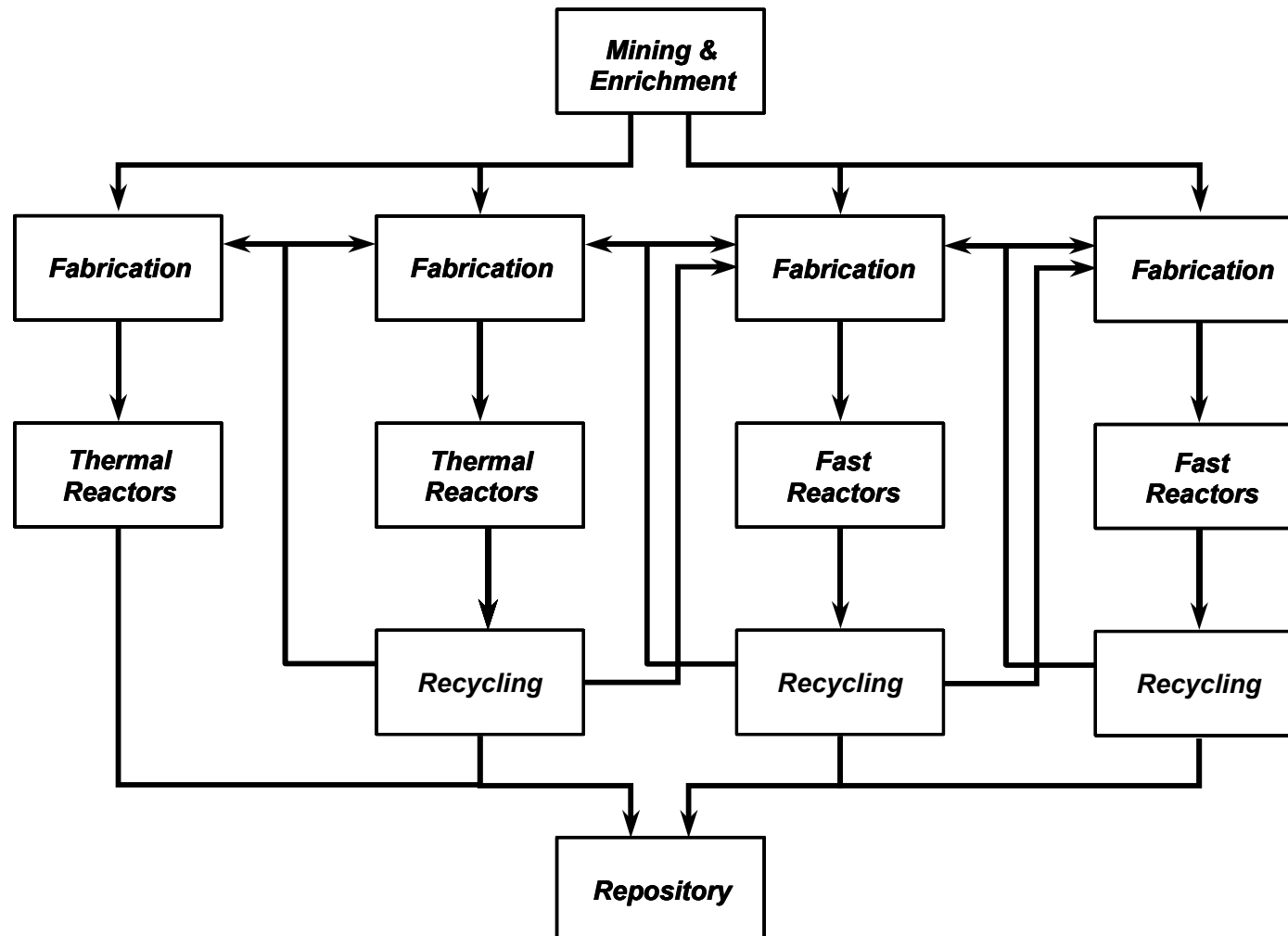




Transmutation Studies and Model Development



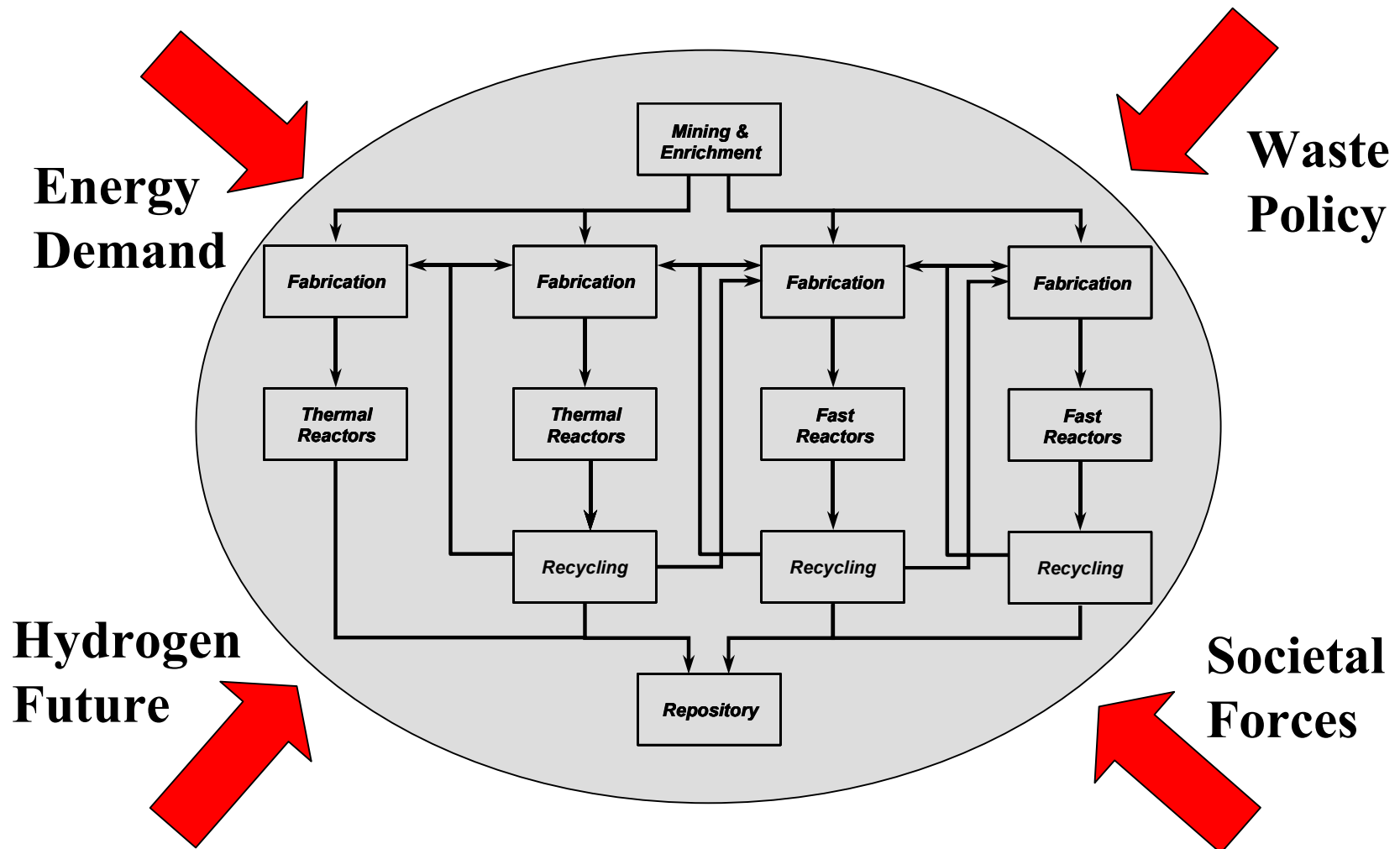
Modeling an ensemble of systems





Broad System Studies

Integrated fuel cycle embedded in scenarios





Systems Analysis Objectives

- **Develop fuel cycle deployment strategies** that are based on the economic, energy, environmental, and nonproliferation benefits of an advanced fuel cycle, balanced by the consideration of its development costs and technology risk.

This objective is supported by the Broad Systems Studies, and Transmutation Studies and Integrated Model Development.

- **Assess and optimize a symbiotic nuclear fuel cycle for the U.S.**, including major alternatives and options.

Transmutation Studies and Integrated Model Development

- **Assess transmutation systems** to compare and optimize Series One and Two.

Transmutation Studies and Integrated Model Development

- **Assess and optimize individual Generation IV systems** for the purpose of comparison and technology selection.

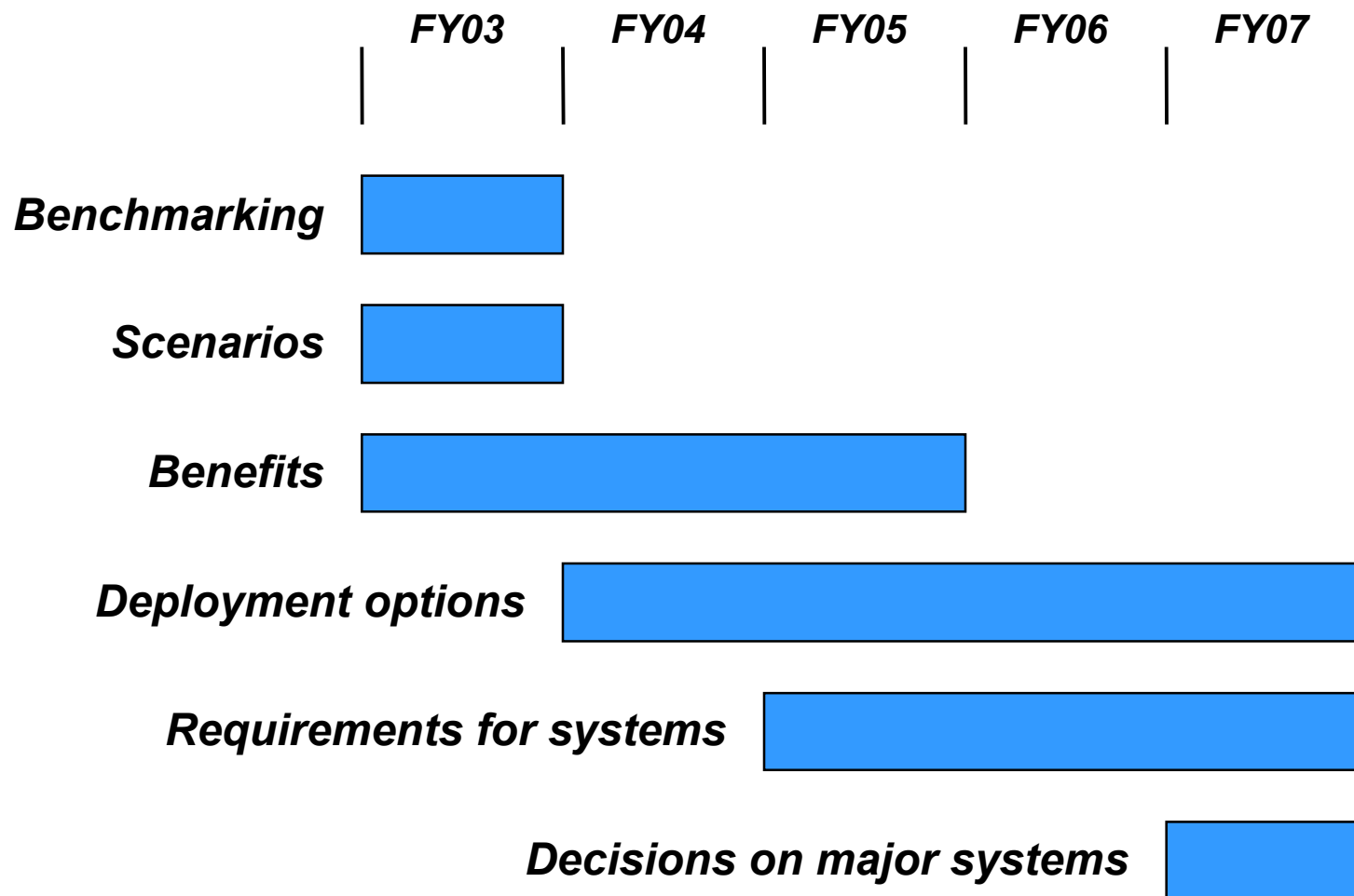
Generation IV Systems Studies

- **Assess performance for specific technology options and facility alternatives** that support the program.

Technology or Facility Assessments



Five-Year Overview of Systems Analysis





Five-Year Milestones and Deliverables



FY 2003

- **Develop and report on bounding scenarios for integrated modeling studies**
- **Initial report of key benefits and technology needs for an advanced fuel cycle in the U.S.**
- **Systematic review of LWR transmutation schemes based on MOX fuel**
- **Summary report comparing reactor- vs. accelerator-based transmutation**
- **Baseline reports on the highest-priority Generation IV systems**
- **Report on Series One point design and licensability**
- **Integrated modeling report**
- **Report on repository benefits**
- **Report on the best option to support AFCI fast neutron facility needs**



Five-Year Milestones and Deliverables



FY 2004

- **Interim report on the key benefits and technology needs of an advanced fuel cycle for the U.S.**
- **Report on integrated modeling studies of the highest priority Generation IV systems to determine their fit into a symbiotic fuel cycle system within the U.S.**
- **Updated baseline reports on the highest priority Generation IV systems**
- **Assess and report on spent fuel treatment deployment options**
- **Assess and report on transient reactor testing needs and options**

FY 2005

- **Initial report on advanced fuel cycle deployment options**
- **Report on integrated modeling studies of the refined Generation IV systems (updated with the technology developments within the Generation IV program) to determine their fit into a symbiotic fuel cycle system within the U.S.**
- **Develop and report on requirements on the Generation IV systems deployed in an advanced fuel cycle within the U.S.**



Five-Year Milestones and Deliverables



FY 2006

- **Interim report on advanced fuel cycle deployment options**
- **Report on integrated modeling studies of the refined Generation IV systems (updated with the technology developments within the Generation IV program) to determine their fit into a symbiotic fuel cycle system within the U.S.**
- **Develop and report on requirements on the subsystems within the Generation IV systems deployed in an advanced fuel cycle within the U.S.**

FY 2007

- **Final report on a U.S. fuel cycle deployment to support major program decisions on spent fuel treatment and recycle, Generation IV technology, and ADS technology development**



Summary

- *AFCI and Generation IV are being integrated*
- *AFCI and Generation IV will study systems in a hierarchy*
- *The major objective is a future, integrated fuel cycle*
- *Special emphasis is given to transmutation studies*
- *Generation IV will emphasize development of:*
 - *Fast-spectrum system(s) for high actinide recycle*
 - *Thermal-spectrum system(s) for hydrogen production and very economical electricity*
- *Requirements on these systems will be done jointly*